§27. Integrated Experimental Process Study for Removal of Tritium and Impurities from Liquid Lithium — II

Fukada, S. (Kyushu Univ.),
Muroga, T.

Introduction

Liquid Li is proposed not only for a blanket material of fusion reactors but also for a flowing target of IFMIF to generate a high-energy neutron beam for the irradiation test of structural materials. Although Li has the most promising blanket properties such as high tritium breeding ratio, large thermal conductivity and so on, the largest disadvantages except for large MHD effect are that the tritium recovery is the most difficult and that Li is reactive with O and N. Therefore, Li purification including T removal is one of the most critical issues for developing fusion reactors and IFMIF. Previously, the removal of O and C is proved experimentally in flowing operation of Na coolant of the fast breeder reactor. However, there is no experimental proof to remove T less than a designed value for fusion reactors or IFMIF (1ppm). Nitrogen is also a target impurity that corrodes structural material during the operation of fusion reactors and IFMIF. In the present report, we focus on the experimental proof of T recovery from Li by Y.

Designing policy of hot trap

Strictly designing the recovery apparatus is necessary to remove T and impurities of C, N, and O less than specified values from the Li loop for fusion reactors or IFMIF. Previously, Y absorption method was proposed for the T recovery from Li, and some experiments were performed. However, the target T concentration in Li is 1 ppm and those of C, O and N are 10 ppm. Removal of C and O can be achieved by cold traps. Preliminary estimation of the absorption equilibrium curves of the Y-H_2 (or T_2) and Li-H_2 (or T_2) isotherms proposes to operate an Y hot trap at 250°C. However, there is no experimental proof to remove T less than 1 ppm in Li. In the present report, the effectiveness of HF treatment was tested to remove oxide that is formed on Y surfaces inevitably.

Experimental proof of T recovery from Li

Li of 50mg in a poly-ethylene capsule under He atmosphere was irradiated in KUR for several minutes under a flux of 2.3×10^{13} neutron/cm^{2}s. The concentration of T generated in Li is 0.07 ppm. Y plate was treated chemically by dipping the surface into 46% HF solution during 5 to 30 min. The Y surfaces were observed by SEM-EDX. We confirmed that its surfaces were changed from Y_2O_3 to YF_3. The neutron-irradiated Li and the HF-treated Y plate were put in a Mo crucible. We had attention not to dispose Y surfaces to Ar flow directly. After the contact between Li and Y during specified hours, Y was dissolved by a HNO_3 solution. Generated HT or HTO were collected by two water bubblers in the experimental apparatus shown in Fig. 1. The total T value corresponds to the amount recovered by Y. T remaining in Li was also dissolved by H_2O, and generated HT and HTO were collected by water bubblers. The chemical form of T generated from Y was HT. The about half of T that remained in Li was HT, and the rest was HTO.

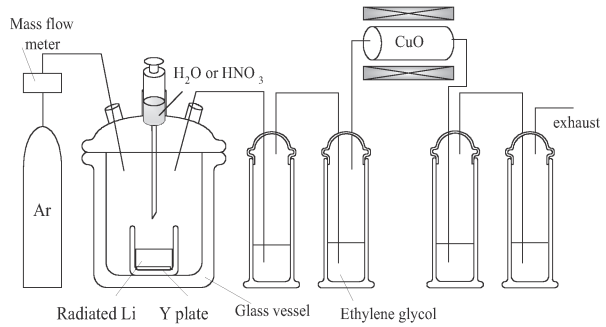

Fig. 1 Apparatus for detecting T absorbed in Li and Y

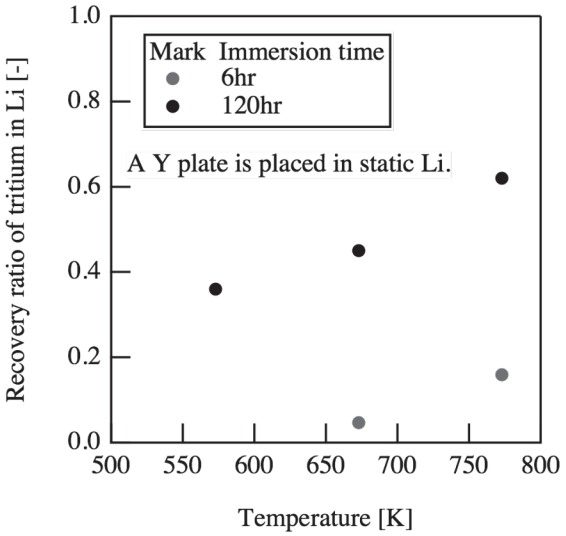

Fig. 2 Tritium recovery ratio by Y plate from static Li

Fig. 2 shows the recovery ratio of T by Y. So that, about half amount of T is surely recovered by Y. The recovery ratio increased with temperature and the contact time regardless of low T concentration generated in Li (0.07ppm). Consequently, we succeeded in proving the recovery of T in Li by the HF-treated Y.

We performed another experiment of H recovery from Li by Y by a gravimetric method. Li and Y put in a ceramic crucible was hung on a gravimetric balance. The mass increase during a certain time under conditions of constant temperature and Ar-H_2 flow was recorded. These results also show the recovery of H in Li by Y successfully.

Table 1 Experimental results of H recovery ratio by use of gravimetric balance

system	temperature	time	mass increase
Li-H_2(1%)	330°C	720min	0.147H/Li
Li-Y-H_2(1%)	330°C	600min	4.56H/Li
Li-Y-H_2(1%)	300°C	900min	0.82H/Li

Reference

(1) S. Fukada, *et al.*, Proc. of Int. Conf. on Tritium Science and Technology (2007).
(2) S. Fukada, *et al.*, Fus. Eng. Des., 82 (2007) 2152.